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DESCRIPTION OF THE IMMATURE STAGES AND BIOLOGY OF *SYNCLITA TINEALIS* MUNROE (LEPIDOPTERA: PYRALIDAE: NYMPHULINAE)[1,2]

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ABSTRACT. The first and last stage larvae and the pupa of *Synclita tinealis* Munroe are described. In addition, the following biological information was obtained. Duration of copulation was ca. 15 minutes. An average of 82 eggs, which hatched in 5 days at 27°C, was laid. Five larval stages with average head capsule widths of 0.22, 0.28, 0.40, 0.52, and 0.62 mm developed from the eggs and lasted ca. 3.9, 2.8, 3.2, 3.1, and 3.2 days, respectively. The duration of the pupal stage ca. 3 days, and the adult life span ca. 4–5 days. Larvae made silk cases and fed primarily on *Lemna* and *Spirodella*.

The adult male and female of *Synclita tinealis* were described by Munroe in 1972; however, no account was given of the immature stages or biology. The early stages and biologies of two of the three other recognized species in this genus found north of Mexico (*S. obliteralis* (Walker) and *S. occidentalis* Lange) have been studied previously (Hart, 1895; Williams, 1944; Lange, 1956a, 1956b), but in neither case have sufficient details been given of the larval or pupal morphology. The immature stages of the fourth species, *S. atlantica* Munroe, are unknown.

In this paper the first and last stage larvae and the pupa of *S. tinealis* are described and an account is given of its biology and behavior in the laboratory.

Materials and Methods

Larvae of *S. tinealis* were collected at four sites in North Carolina: Merchants Mill Pond, Gates Co.; Holt's Pond, Johnston Co.; Pledger's Landing, Tyrell Co.; and Lake Ann, Wake Co. In all cases the host plants were duckweeds (Lemnaceae) of either the genus *Lemna* or *Spirodella*. Several generations were reared from material collected at Merchants Mill Pond; most of the following information is based on this material.

Larvae were reared in either 35 cm^3 or 60 cm^3 jelly cups or in glass petri dishes. *Lemna*, *Spirodella*, or portions of other host plants were placed in each container, which was then partially filled with water. Moths paired for mating were confined under 300 cm^3 plastic cups

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inverted over water filled petri dishes containing *Lemna* or *Spirodella.*

All descriptions and measurements given are of larvae and pupae fixed in KAAD and preserved in ethanol. Genitalia slides were prepared of several reared adult males, and the species was identified by reference to Munroe (1972).

Morphological observations and illustrations were made with the aid of both compound and stereomicroscopes, a camera lucida, and an ETEC Autoscan scanning electron microscope. Material for SEM studies was prepared by critical point drying and gold coating.

The nomenclature of larval setae and punctures follows Hinton (1946), terminology of pupal sclerites follows Mosher (1916), and host plant names follow Radford et al. (1968).

Synclita tinealis Munroe

Synclita tinealis Munroe, 1972: 97.

First Stage Larva

General. Length 1.16–1.38 mm, avg. 1.28 mm. Width at abdominal segment 3, 0.22–0.28 mm, avg. 0.25 mm. Entire larva translucent white. Only 3 ocelli apparently present, corresponding to anterior 3 in last stage larva. Labrum and hypopharynx as in Figs. 3 and 4. Antennae about ½ head capsule length. Mandibles (Fig. 1) pale translucent reddish brown to amber. Cuticle elevated into simple hydrophil papillae covering all body surfaces except head, prothoracic shield, and legs. Diameter of papillae on mesothorax ca. 2.1 μ. Density of papillae ca. 100,000 per mm^2.

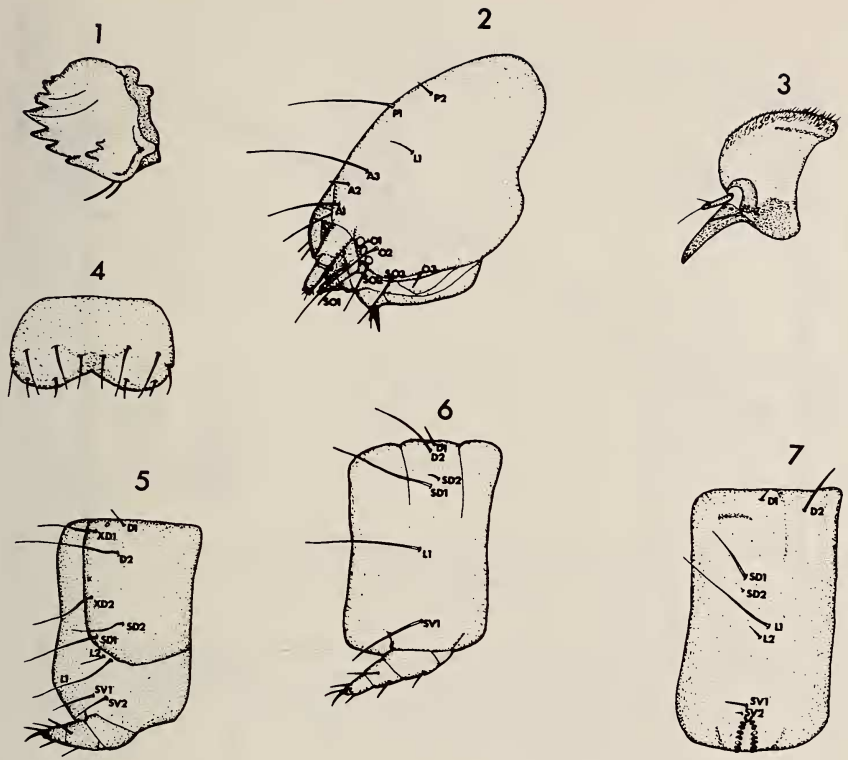
Head. Width 0.19–0.22 mm, avg. 0.22 mm; epicranial index ca. 3.0; antennal segment 2 about 2 times length of segment 1; mandibles ca. 0.05 × 0.06 mm, with 8 to 9 teeth (6 or 7, some showing faint dorsal serrations, along distal margin, and 2 on oral surface near ventral margin); hypopharynx and spinneret as in Fig. 3; labrum as in Fig. 4; setae 01, 02, and 03 in nearly straight line (Fig. 2); 03 closer to S03 than to 02; distances from A1 to A2 and from A2 to A3 approximately equal; setae A1, A2, A3, and L1 and setae P1, P2, and F1 in approximately straight lines; distance between P2 setae greater than between P1 setae.

Prothorax. Width 0.26–0.28 mm, avg. 0.27 mm; shield and leg sclerites smooth, other areas covered with minute hydrophil papillae; seta D2 4½ times longer than D1, SD1 slightly longer than SD2, L1 4 times as long as L2; SV1 and SV2 subequal in length; distance between XD1 setae greater than between D1 setae; seta XD2 closer to SD1 than to XD1; other setae as in Fig. 5; spiracle apparently absent.

Mesothorax. All surfaces except leg sclerites covered with hydrophil papillae; only one L seta present; other setae as in Fig. 6.

Metathorax. Similar to mesothorax.

Abdomen. Prolegs reduced, crochets on segments 3–6 in narrow, uniordinal lateral penellipse, with posterior hooks slightly larger than anterior hooks; crochets of anal prolegs in transverse uniordinal band; number of crochets on prolegs of segments 3, 4, 5, and 6 and on the anal proleg 17–21, 18–20, 20–22, 18–21, and 8–9 respectively; setae D2, SD1, and L1 relatively long; D2 more than 3 times length of D1, SD2 extremely minute, L1 more than 6 times length of L2; abdominal segments 3–6 with 2 SV setae; only 1 SV seta on abdominal segments 1, 2, 7, 8, and 9; SV2, when present, much shorter and less conspicuous than SV1; on abdominal segment 10 setae D2 and SD2 adjacent with SD2 considerably longer than D2; spiracles apparently absent (Fig. 7).



FIGS. 1–7. 1st stage *Synclita tinealis* larva: **1.** right mandible, mesal view; **2.** head, lateral view; **3.** hypopharynx, lateral view; **4.** labrum, dorsal view; **5.** prothorax, lateral view; **6.** mesothorax, lateral view; **7.** abdominal segment 6, lateral view.

Last Stage Larva

General. Length 7.8–9.2 mm, avg. 8.2 mm. Width 1.4–1.6 mm, avg 1.5 mm. Head capsule (Fig. 12) translucent, white to pale brownish-yellow, with darker band extending from behind ocelli to posterior margin; labrum (Fig. 10) pale amber, shallowly notched, with anterior edge dark brown; mandibles (Fig. 9) amber to yellowish-brown, with reddish-brown teeth; hypopharynx and antennae white; spinneret and sclerites of maxillae light brown. Prothoracic shield (Fig. 13) pale amber to light brown, with darker brown spots along top and in arc paralleling ventral and posterior margins; antero-lateral and ventral rim of prothorax unpigmented; remaining areas of thorax and abdomen essentially white. Hydrofuge hairs on all body surfaces except head, anterior ⅓ and entire venter of prothorax, prothoracic shield, anterior ⅔ of venter of mesothorax, thoracic legs, plantae of prolegs, and anal region.

Head. Width 0.59–0.65 mm, avg. 0.62 mm; epicranial index ca. 3.3; surface smooth; antennae long, slender and with antacora elongate and conical; antennal segment 2 about 3 times length of segment 1, both partially retractable into antacora; ocelli 6 in number; nos. 3, 4, and 5 in straight line, with 3 and 4 contiguous; lenses of ocelli 1 and 2 indistinct; ocellus 6 represented by pigmented spot only or apparently absent; mandibles ca. 0.15 × 0.15 mm, with continuous arc of 9 to 11 teeth, including 5 to 6 distal

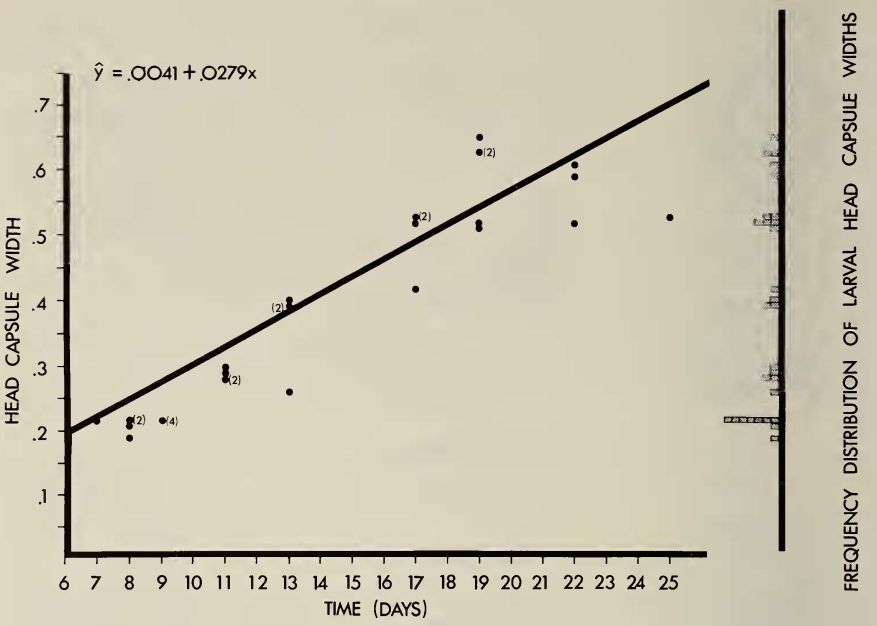
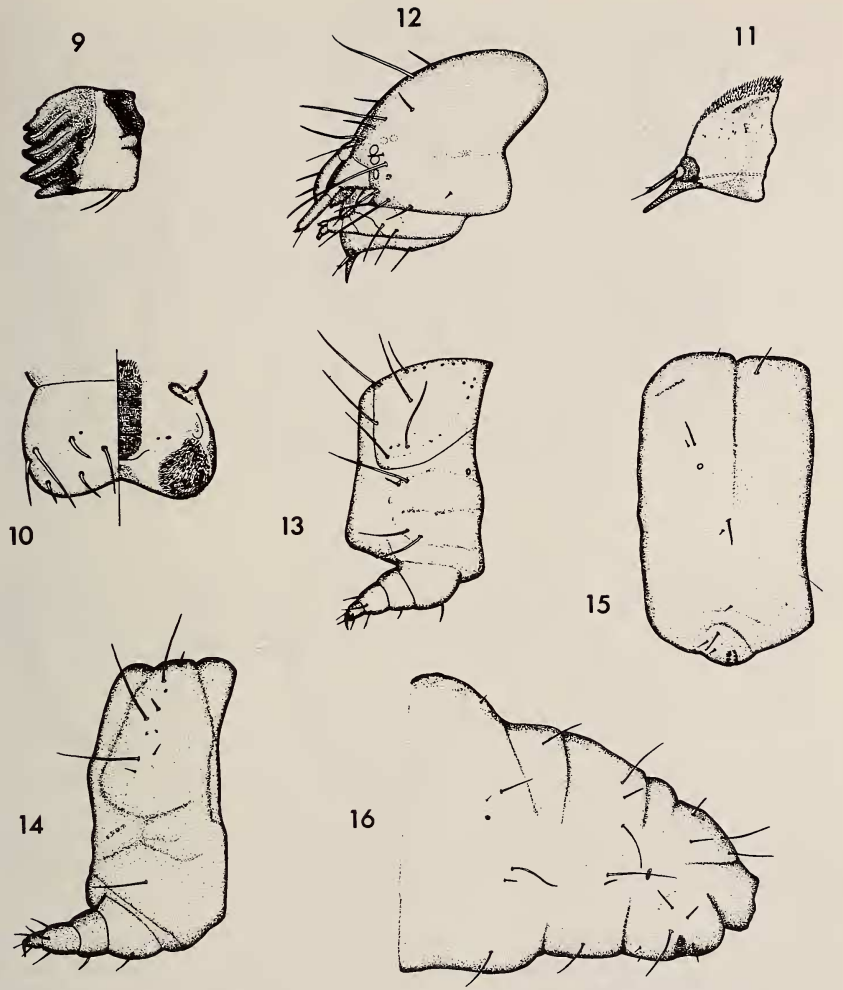


FIG. 8. Linear regression of head capsule width and developmental time of *S. tinealis* at 27°C. $R^2 = 0.857$. Eggs laid on day 1, hatched on day 6; pupae present on days 22 and 25; 10 adults emerged on day 25. Frequency distribution of head capsule widths given at right of figure. Each block indicates one larva.

teeth and row of 4 to 5 smaller teeth on oral surface near ventral margin of mandible; two postero-ventral mandibular setae present, both well developed and with anterior seta somewhat longer than posterior seta; hypopharynx and spinneret as in Fig. 11; maxillae with long seta-like processes on mesal surface; labrum and epipharynx as in Fig. 10; setae 01, 02, and 03 in nearly straight line; 03 closer to S03 than to 02, seta 03 longer than 01, seta 02 much longer than 01 or 03; distance 02 to 03 more than 3 times distance 01 to 02; setae A1, A2, A3, and L1 in nearly straight line; setae A3 somewhat longer than A1; A1 about 2 times length of A2; distances A1 to A2 and A2 to A3 approximately equal; A3 closer to A2 than to L1; L1 and A2 nearly equal in length; setae P1, P2, and F1 in nearly straight line; distance between P2 setae greater than between P1 setae; Af1 and Af2 both very short and thin; F1 of moderate length; C1 usually longer and thicker than C2; S0 setae as in Fig. 12.

Prothorax. Width 0.83–0.92 mm, avg. 0.87 mm; shield and leg sclerites smooth; anterolateral and ventral regions of prothorax with hydrophil papillae; posterolateral region raised and with fine hydrofuge pubescence; spiracle small, ca. 0.03 mm in diameter; D2 about 2½ times length of D1, XD1 and XD2 of approximately equal length, SD2 slightly longer than SD1, L1 much longer than L2, and SV1 slightly longer than SV2; distance between XD1 setae greater than between D1 setae, distance XD1 to XD2 greater than distance XD1 to D1, distance D1 to D2 greater than distance D1 to XD1, distance SD1 to SD2 less than distance SD1 to XD2, and distances XD1 to XD2 and XD2 to SD1 approximately equal; coxae contiguous on midventral line.

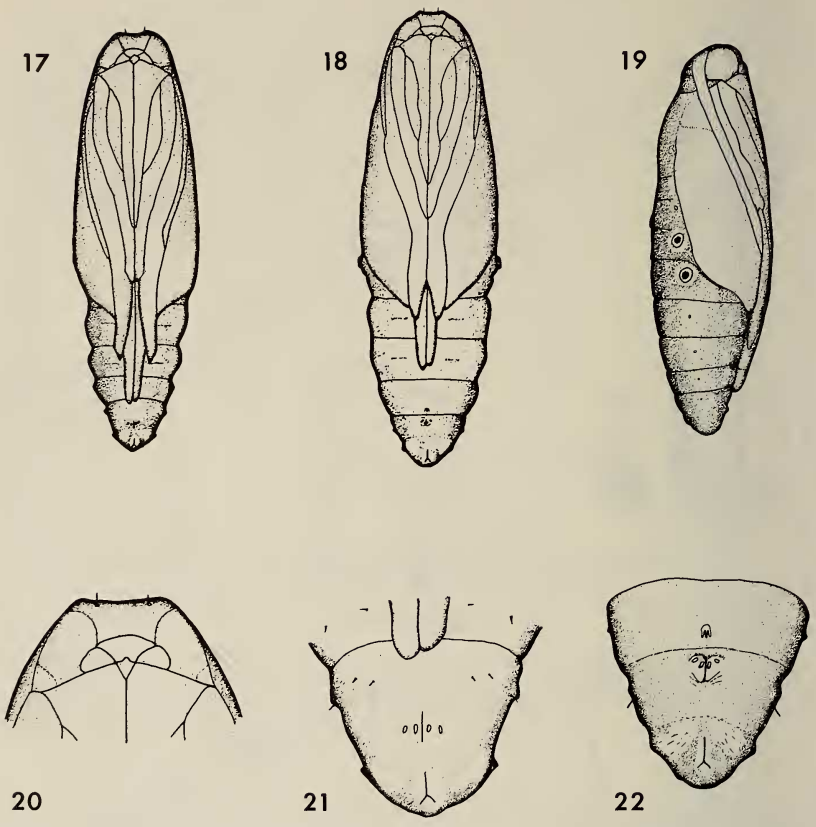
Mesothorax. Surface entirely covered with hydrofuge pubescence, except anterior ⅔ of venter, and legs; setae D2, SD1, L1, and SV1 prominent (Fig. 14); D1 and SD2 very small; L2 and L3 minute; separation of coxae ca. 0.03 mm.



FIGS. 9–16. Last stage *Synclita tinealis* larva: **9.** right mandible, mesal view; **10.** labrum (dorsal surface to left and ventral surface to right of vertical line); **11.** hypopharynx, lateral view; **12.** head, lateral view; **13.** prothorax, lateral view; **14.** mesothorax, lateral view; **15.** abdominal segment 6, lateral view; **16.** abdominal segments 8–10, lateral view.

Metathorax. Entire surface, except legs, entirely covered with hydrofuge pubescence; setae as on mesothorax; separation of coxae ca. 0.25 mm.

Abdomen. Prolegs reduced; crochets on segments 3–6 in transverse biordinal bands with anterior hooks larger than posterior, difference becoming more pronounced caudad; crochets of each anal proleg in single transverse biordinal band; number of crochets on prolegs of segments 3, 4, 5, and 6, and on anal proleg 33–39, 34–41, 36–49, 38–44, and 10–12, respectively; all setae on abdominal segments 1–8 greatly reduced in both length and thickness; D2 about 3 times as long as D1, L1 more than 3 times



FIGS. 17–22. *Synclita tinealis* pupae: **17.** male pupa, ventral view; **18.** female pupa, ventral view; **19.** male pupa, lateral view; **20.** male pupa, head; **21.** male, abdominal segments 7–10, ventral view; **22.** female, abdominal segments 7–10, ventral view.

length of L2 or L3; distance between D1 setae less than between D2 setae (Fig. 15); 2 SV setae on abdominal segments 1 and 7, 3 present on segments 2–6, only 1 on segments 8 and 9; SV2 and SV3, when present, much shorter and thinner than SV1; on abdominal segment 9 (Fig. 16), setae D2, SD1, and L1 relatively longer than on more anterior segments; SD2 and L3 apparently absent; on abdominal segment 10, D2 and SD2 adjacent and about equal in length; D1 and SD1 less prominent, SD1 equal in length to D1 and located directly ventral of D1; L2 about 2½ times length of L1 or L3 and only slightly closer to L1 than to L3.

Pupa

General. Female (Fig. 18): Length 4.0–5.0 mm, avg. 4.6 mm. Width 1.41–1.51 mm, avg. 1.45 mm. Male (Figs. 17, 19): Length 3.6–3.7 mm, avg. 3.7 mm. Width 1.08–1.09 mm, avg. 1.09 mm. Head, thorax, and abdomen white to pale brownish-yellow, darkening as moth within develops.

Head. Vertex slightly depressed (Fig. 20), epicranial suture absent; labrum distinctly separated from clypeus; pilifers set off as distinct sclerites, separated by labrum and

labial palpi; length of antennae of male ca. 0.5 total body length; length of antennae of female ca. 0.28 total body length; sclerite of labial palpi small, undivided; length of maxillae of male ca. 0.68 length of wings (both measured from caudal margin of labrum); length of maxillae of female ca. 0.55 wing length; maxillary palpi distinct.

Thorax. Prothoracic legs of female extend to segment 3, mesothoracic legs reach middle of segment 5, and metathoracic legs extend just past middle of segment 6; prothoracic, mesothoracic and metathoracic legs of male reach segments 4, middle of 6, and 8 respectively; mesothoracic legs of female broadly joined along midventral line; mesothoracic legs of male separate for entire length; mesothoracic spiracle not visible; tegulae only faintly indicated.

Abdomen. Proleg scars faint but visible on segments 5 and 6; setae very inconspicuous; spiracles of abdominal segment 2 ca. 0.04 mm in diameter; spiracles on abdominal segments 3 and 4 enlarged, somewhat elliptical and situated on raised conical tubercles; dimensions for each spiracle in female ca. 0.18 × 0.16 mm, and in male ca. 0.12 × 0.11 mm; spiracles of segments 5–8 very small, ca. 0.02 mm in diameter, and not readily discernible; segments 6–9 with pairs of small, papilla-like dorso-lateral tubercles, increasing in size on more posterior segments; female genital openings (Fig. 22) confluent, apparently located on segment 8, and flanked by two pairs of papillae; male genital opening (Fig. 21) on ventro-meson of segment 9 and also flanked by two pairs of papillae; unidentified "M"-shaped structure on segment 7 of female, anterior to genital opening.

Material Examined

North Carolina: Gates Co., Merchants Mill Pond, 9 1st stage larvae, 5 last stage larvae, 7 pupae, on *Spirodella polyrrhiza* (L.) Schleiden, *Lemna valdiviana* Philippi, and *Lemna perpusilla* Torrey, 9-II-1975, Coll. P. D. Kinser.

Biology

The mating behavior of three pairs of moths was observed in the laboratory. Prior to copulation, the female assumed a posture with the abdomen steeply elevated and the ovipositor extruded perpendicularly to the surface on which the moth rested. Males were more active and tended to fly around the enclosure frequently. After the male located and made contact with a female, the female lowered the abdomen and withdrew the ovipositor. In copulation the moths are joined end to end, with the wings of the male resting on those of the female. Mating can occur in either sex within the first day after emergence. Copulation lasted an average of 14½ minutes (10, 17, 16½ minutes), and oviposition started after an average of 48 minutes (28, 84, 32½ minutes). No multiple matings were observed.

In ovipositing, the female moth rested on the host plant and deposited eggs singly or in small groups of up to 10 on the lower surface of the host plant fronds about 1 mm from the margin. The eggs are oval and flattened and measure about 0.52 × 0.40 mm. During development the eggs increase somewhat in size. This has been previously noted by Berg (1950) and Welch (1916) for the eggs of *Munroessa icciusalis* and *Parapoynx maculalis*, respectively. The first oviposition lasted about 24 minutes and an average of 43 eggs was laid. A

second oviposition occurred in two instances about 30 minutes after the first had ceased, and about 20 more eggs were laid. Small numbers of additional eggs were also deposited during the next several days. The total numbers of eggs laid by these and four other moths ranged from 38 to 139 (avg. 82).

The eggs of *Synclita tinealis* were found to hatch in about 1 week (5 days at 27°C, 8 days at 21°C, 13 days at 16°C). The hatching process was not observed, but the newly hatched larvae began feeding and case making during the first day after hatching. No egg or larval cannibalism was observed; the larvae tended to avoid eggs and each other. First stage larvae remained on the under surface of the leaves of the host plant. They began case construction by cutting a groove at the edge of a frond along a semicircular line with a radius about equal to their own length. Then the larva pulled itself, together with the semicircular fragment which it had detached, under the remaining portion of the frond. Next, the larva attached this fragment with silk to the frond. At a later time the larva was seen to cut a matching patch from the upper frond and free the case. These first cases were flat, loosely bound together and had little inner lining. The larva expanded its case gradually by adding additional pieces of frond, or later whole fronds, to the original case. As the larva and its case increased in size, the older portions of the case were often cut off and discarded. The cases of older larvae were increasingly well made. The frond fragments or fronds that were added to the case were bent to conform to the general shape of the larva and firmly attached to the case, which at this time had a delicate silk lining. Several observations were made in which larvae seemed to inspect and lay down a meshwork of silk on all surfaces of a piece of leaf to be added to the case. This possibly facilitated manipulation and provided the prolegs a better grasp of the substrate. Both ends of the case remained open and larvae were observed to turn around in it readily. Feeding and casemaking appeared to be largely uninhibited by light, and larvae fed on any of the surfaces or along the edges of a frond. In some instances in which there was a shortage of the preferred host plant, detritus of various sorts was incorporated into the larval cases. Larvae separated from food withdrew partially from their cases and moved the front halves of their bodies in broad circles in the water until food was located.

Pupation took place in the last larval case, which was completely and densely lined with silk and usually left floating.

Information on the number of larval stages and development was secured from a laboratory culture (Fig. 8). A total of 121 eggs was laid by one moth on March 17 on *Spirodella polyrrhiza* in the laboratory. These were placed in a constant temperature room at 27°C on March

19 and hatched on March 22. The following day 100 larvae were put into separate 35 cm^3 jelly cups filled partially with water, into which fronds of *Spirodella* and *Lemna* had been placed. At intervals during the following weeks samples from five cups were taken and the larvae preserved. A total of 45 cups were sampled and 30 larvae recovered. Larvae in the remaining cups had either died or pupated. Head capsule widths were measured and the stages identified as follows: 1st stage: 0.19–0.22 mm, avg. 0.22 mm; 2nd stage: 0.26–0.30 mm, avg. 0.28 mm; 3rd stage: 0.39–0.42 mm, avg. 0.40 mm; 4th stage: 0.51–0.53 mm, avg. 0.52 mm; 5th stage: 0.59–0.65 mm, avg. 0.62 mm. Sampling was discontinued on April 10, as by that time all larvae had pupated and the emergence of adults had begun. Some information was also gained on the developmental times of the larvae and other stages, although a considerable overlap became apparent toward the end of the rearing period. This may have been due to differences in the quality and amount of food given to each larva. At one time many larvae temporarily ran out of food, and in a number of instances, early stage larvae became separated from the host plant and had to be pushed back into contact with it. Sexual dimorphism may also have been a factor. The following approximate durations for each stage were derived from the data that were collected: egg: 5 days; 1st instar: 3.9 days; 2nd instar: 2.8 days; 3rd instar: 3.2 days; 4th instar: 3.1 days, 5th instar: 3.2 days; pupa ca. 3 days; adult: 4–5 days.

Additional observations were made on feeding preference, antagonistic behavior, movement, and defecation. A variety of aquatic plants in diverse families was presented to larvae. These included *Azolla caroliniana* Willdenow (Azollaceae), *Spirodella polyrrhiza*, *Lemna perpusilla*, and *Lemna valdiviana* Philippi (Lemnaceae), *Elodea canadensis* Michaux (Hydrocharitaceae), *Myriophyllum brasiliense* Cambessedes (Haloragaceae), *Potamogeton pulcher* Tuckerman (Potamogetonaceae), *Polygonum* sp. prob. *hydropiperoides* Michaux (Polygonaceae), and *Nuphar luteum* (L.) Sibthorp & Smith (Nymphaeaceae). It was found that plants in the Lemnaceae were preferred, *Azolla*, *Elodea*, and *Myriophyllum* were fed on moderately, and the others, *Potamogeton*, *Polygonum*, and *Nuphar*, were not utilized to any appreciable extent. Larvae under crowded conditions or deprived of food devoured their own cases and those of neighboring larvae; however, the inner layer of frond tissue and the silk lining were usually left. Larvae whose cases were attacked vigorously thrashed from side to side in their cases or more rarely attempted to bite the other larva. In many instances the thrashing alone was enough to prompt the attacking larva to reverse direction in its case and search for food in another direction. This same movement also

was used at times by the larva to effect movement away from adverse situations or to regain contact with the host plant. Defecation in this species was quite forceful, with fecal pellets being propelled some distance from the case.

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